Review of "Multi-annual patterns of rapidly draining supraglacial lakes in Northeast Greenland" by Katrina Lutz et al submitted to *The Cryosphere*
Review prepared December 2024

Overview
This manuscript investigates the spatial and temporal variability of supraglacial lake drainages on two major glaciers in Northeast Greenland—Zachariae Isstrom and 79N Glacier—during the 2016–2022 melt seasons. Using Sentinel-2 imagery, the study tracks individual lakes to identify drainage events and explores potential correlations with factors such as ice strain rate, elevation, lake volume, and seasonal temperature.

The findings reveal significant variability in drainage patterns, including the occurrence of chain drainages and temporal clustering at higher elevations, but limited correlation with the investigated environmental factors. The authors suggest a critical role of crevasses within lake boundaries as a precondition for rapid drainage events and emphasize the need for higher-resolution remote sensing or in situ data to refine understanding of these mechanisms. This manuscript adds important insights into supraglacial lake dynamics in Greenland, despite lack of finding a coherent mechanism triggering lake drainages.

I found the manuscript to be overall well-designed, referenced, and written, and that it is supported by detailed, yet clear, figures. I think the article is very well-suited for publication in The Cryosphere after a few relatively minor changes. Below I list a couple broader comments that I'd like the authors to consider followed by a few specific comments. I thank the authors in advance for considering these comments.

Sincerely,
Luke Trusel

Broader comments
The authors have effectively assessed relationships between lake water volumes and drainage patterns. However, I'd suggest that the study might benefit from incorporating maximum lake depth as the primary parameter, as it more directly relates to hydrofracture potential given that water depth influences the pressure exerted at the lake bottom (e.g., van der Veen, 2007). My concern is that by only looking at lake volume, the analysis could overlook instances where smaller but deep lake lakes possesses a higher propensity for hydrofracture compared to larger but shallower lakes.

My second comment relates to the analysis between summer air temperature and drainage as illustrated in Figure 6. I wonder if the authors may have overlooked a potential explanation for the observed peak in rapid drainages in the warmer (presumably higher-melt) year of 2019, which followed the colder, lower-melt year of 2018. I would expect that the limited meltwater and fewer drainages in 2018 likely resulted in a less efficient subglacial hydrological system due to reduced flushing and connectivity of basal drainage

pathways. In such conditions, a sudden influx of meltwater in the following high-melt year (2019) could have increased basal water pressure and enhanced basal slip in the inefficient basal hydrological system, triggering an ice dynamical response and more drainages. This could also help explain the apparent larger clusters of chain-reaction drainages in 2019 as illustrated in Figure 3. This idea would align with the findings of Stevens et al (2015), where (if I recall correctly) they demonstrate inefficient basal drainage systems after periods of low melt can amplify the effects of subsequent drainage events, including basal slip and tensile stresses that propagate to neighboring lakes.

Specific comments

Introduction paragraph 1: While the paragraph overall is well referenced, there are multiple sentences here without supporting references. I'd suggest more specifically connecting the statements in the text to the cited literature rather than just clumping the references together.

L49: Please be more specific to which study "Here" is referencing.

L68: Glacier's -> Glaciers'

L85: Could you please clarify how a rapid drainage was defined. I found the method description here somewhat vague – is it a drainage occurring anywhere from 1 to 10 days, with many being 5 days or less? Some clarity in the description would be helpful. You may also consider stating (or mapping) the average time constraint between lake observations related to drainages.

L102+L103: Was -> were

L121: Some words out of place here: change to "The temporal and spatial variations" (or similar)

L148: Add "near-" before simultaneously?

Figure 3: Just commenting to say this is a very nice figure with interesting results!

L178: Make 3's superscript.

L203-206: The two sentences here repeat. Delete one.

L222 (and elsewhere): These are presumably summer surface **air** temperatures, correct? Surface temperature alone implies the skin temperature rather than near-surface air temperature.

L278-281: The couple sentences following "Upon…" are confusing to me. The first implies that the lakes are too small for a fracture to stay within the lake for more than one year,

whereas the second says the lakes are large enough to have the fracture stay within the lake. Could you please clarify these statements?

References from this review

Stevens, L. A., Behn, M. D., McGuire, J. J., Das, S. B., Joughin, I., Herring, T., Shean, D. E., and King, M. A.: Greenland supraglacial lake drainages triggered by hydrologically induced basal slip, Nature, 522, 73–76, https://doi.org/10.1038/nature14480, 2015.

van der Veen, C. J.: Fracture propagation as means of rapidly transferring surface meltwater to the base of glaciers, Geophys. Res. Lett., 34, L01501, https://doi.org/10.1029/2006GL028385, 2007.